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ABSTRACT

Since the advent of reform in mathematics education, writing in mathematics courses has taken on an increasingly important role. This paper discusses what one teacher has done over time to incorporate writing into calculus classes and how the techniques employed have evolved over time. The focus is on journal writing, extended exercises, and lab-based exercises. Several recommendations are made to increase the effectiveness of writing exercises in mathematics classes. (DDR)

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Writing in My Calculus Classroom: An Evolution

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Writing in My Calculus Classroom: An Evolution.

A presentation given at the Sixth Conference on the Teaching of Mathematics,
Milwaukee, WI June 20, 21, 1997
by
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Abstract

Since the advent of the reform in mathematics education, writing in mathematics courses has taken on an increasingly important role. In this presentation, I will discuss what I have done to incorporate writing into my calculus courses, how it evolved over time, and what I do now.

Introduction

Five years ago I began using writing assignments in my calculus courses and I would like to spend the next ten to fifteen minutes talking about how that activity evolved for me. I want to begin with some history some of which is ancient and some more recent.

Thirty years ago when I first started in this profession, one of my assignments was to teach a liberal arts mathematics course and as one of the requirements, I had the students write a term paper. The topic of the paper was to be a biography of some famous mathematician and I remember suggesting E. T. Bell's book, *Men of Mathematics* as a primary source. As it turned out, this was not a good experience for me; the level of writing in the majority of these papers was not what I had expected from college students and I came to the conclusion that such assignments were best left for more writing intensive courses such as history or literature and that writing assignments were probably not a good idea in a mathematics course.

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However, times change and given my experiences over the past few years I now realize that such a conclusion was wrong because I have been incorporating writing assignments more and more into my calculus courses with greater success. I would like to share some of my experiences along these lines with you and perhaps encourage you to give such assignments a try in your courses.

As for the more recent history, about five years ago the faculty of the Mathematics Department at the College of Saint Rose where I'm employed made some major changes in the way we teach mathematics. One of the changes involved the implementation of a computer classroom for the sole use of the mathematics department. This classroom has twenty-one computers all equipped with the Maple V computer algebra system. Almost all of our mathematics courses now meet in this facility where we attempt to interactively involve the students in whatever course is being taught. The other major change we made was to adopt one of the calculus reform projects; in particular, we adopted the Harvard program.

At the time we were making the department wide changes, I decided that perhaps I would make some changes in the way I had been personally teaching. One way I would do this, I thought, would be to incorporate writing assignments into my courses and since the calculus program was new, I felt that that would be a good place to start.

Over the years, I have used several methods for doing this, some good, some not-so-good but the conclusions I have come to, notwithstanding my previous experience, is that writing assignments are a good thing to use in a mathematics course. So let me turn to the various methods I have used.

Journals

The way I going to present these various methods is not chronological but rather in the order of my own preferences so let me explain the journal method first since that was my least favorite, the one I used for the shortest length of time, and the one I had some mixed feelings about.

In this method, the student is to keep a daily diary of the what goes on in class. That is, they're to keep daily notes on their impressions of the class including such things as what they understood or did not understand, difficulty of the homework assignments, class work, presentation of new material, etc. The idea is to get students to put their personal impressions of the class and, indirectly, of the mathematics on paper. Hopefully, by getting the student to write about his or her class experiences on a daily basis would force them to think more deeply about the course and its content.

I did not find this use of writing to be particularly satisfying. The vast majority of the students kept the journal as though they were making entries in a date book. For example a typical entry might be: "Today we learned to differentiate x^2, I learned that in high school." Another entry might be: "I did problem 16 at the board today, I did it right." Occasionally, a few students actually wrote something of substance: "We began by learning how to use the Maple computer program. This is a great program that I wish I had in high school. It has a lot of potential and I'm looking forward to using it and to this course."

For the most part, though, I was not pleased with what I was seeing in these journals; they contained very little mathematics despite my prodding. Additionally, I had a problem assigning credit to this activity. I wanted the students to gain something from keeping these journals yet the results seemed to have only a superficial relationship with what was going on in class.

Now I said that I had mixed feelings about this method but only because I had the impression that I had misunderstood the use of the journals and was not using them in the way they were intended to be used. At any rate, I felt that they did not meet the goal I had set when I first decided to use writing assignments in my course. In any event, I abandoned this activity after a semester.

Extended Exercises

When I first decided to use writing assignments my goal was a simple one; namely, to have the students write a theme of about two to three pages on some topic that was germane to the material we were currently discussing in the class. The use of these extended exercises or "turn-in" problems, as I sometimes called them, seemed to meet this goal rather well.

Now chronologically, I had used this activity before my attempts with the journals. I think that it is a good way to introduce writing into a calculus or other mathematics course because it is simple and easy to implement. Here's what I did. The first semester I taught from the Harvard Calculus text, I went through the book and choose about five or six problems from the chapters I planned to cover that, in my opinion, were not practical for a student to present in a class of seventy minutes. (One of my practices is to have students put the assigned homework problems on the board for discussion. My calculus sections meet three times a week and calculus is a four credit course necessitating the seventy minute classes.) I then assigned these problems as writing projects to be turned in at various times throughout the semester. Usually, but not always, an assigned problem was to be due when we were discussing the material pertaining to the problem in class. In fact, this was probably the only drawback, though only a minor one, to using

this method; that is, there were times when an assignment was due and we'd be on a different topic.

Since grading such exercises is time-consuming, I had to set down some rules for their preparation. For example, I required that the assignments be typewritten or word-processed and, as I mentioned before, they were to be no more than two or three pages in length. Of course, I penalized bad grammar and spelling. Since typing mathematics and including graphs are not the easiest tasks, I allowed mathematical notation to be neatly inserted by hand as could plots of functions or other graphs necessary for the presentation of the solution. These rules were not a great detriment because on our campus, there are enough open computer labs with quality word processors to allow easy access by most students at almost any time of day or night.

Needless to say, this method was more satisfying from my point of view and the student's. The assignments related more directly to the course material, they were easier to grade, and the students were actually writing mathematics.

Lab-Based Exercises

Lately, I have taken another approach to including writing into my calculus courses. As I mentioned before, at the College of Saint Rose, the mathematics department is fortunate to have a computer classroom in which all of the computers are equipped with the Maple V computer mathematics system. In addition, Maple is on most of the computers in the other computer labs on campus and so is available to our students at almost any time. It had been on the back of mind to incorporate this technology more directly into the writing assignments I was making but I didn't give this aspect of it any serious thought until the Fall of 1994. During that semester the computer lab manual, *Exploring Calculus with Maple* was published by John Wiley & Sons as a supplement to the

Harvard Calculus text. The lab projects in it are in fact, cross-referenced with the chapters in the Harvard textbook so that it is easy to make an assignment that corresponds to the topic we are currently discussing in class. I took this opportunity to include the technology we have available into the writing assignments.

So for the past few years I have been making writing assignments that are taken from this lab manual. I have also increased the number of writing assignments to about one a week (actually, about 10 per semester) but I haven't changed my initial requirements for the written reports. Since the process of preparing a well-written report requires a combination of experimentation and organization, I emphasize that they work through the lab first making any notes necessary on the tear-out sheets provided in the manual. I stress that only when they have worked through the assigned lab completely are they ready to organize their results into the written report. The manual even provides several "solved problems" which has been my practice to work through with them in class as a preliminary to the actual lab assignment. Even though the focus of the writing assignments as changed somewhat, I still require a typewritten or word processed report of about two or three pages. I expect their reports to be written in complete, logical sentences using good grammar. Now I don't become overly concerned with every comma or preposition, but I do feel that it is important to correct both their English and their mathematical grammar. This is primarily a problem during the first semester. Since these students are, for the most part, freshmen and are not quite sure what to expect, I spend a good deal of time correcting and annotating their first few reports. After I return the corrected assignment, I prepare an example report for that assignment and make this available to them. I should also mention that at the beginning of the semester I hand out the requirements for the reports together with an example that hopefully will serve as a model to get them started

As the school year progresses, most of the students are preparing fairly well-written reports and this allows me to concentrate more on the mathematics they have written.

This method has been more satisfactory that either of the other approaches I have used. It is certainly more satisfying than the journals and more satisfying than the extended exercises only because they allow me to incorporate our available technology. The lab assignments seem to engage the students more than the extended exercises and are more germane to the material currently being discussed in class.

For those of you that wish to try using writing assignments in your courses, and I would certainly encourage you to do so, here are some suggestions that I have gleaned over the past five years that may prove helpful.

Some Helpful Suggestions

1. Set a general goal or purpose for the writing assignments you make.
    - Mine is to have the students write a theme of about two to three pages on some topic that is germane to the material we are currently discussing in the class.

2. Make your expectations regarding the final report very clear and stick to them; do not accept anything less.

3. Allow adequate time for the student to prepare the assignment.
    - For the lab-based assignments, a week appears to be sufficient while approximately two to three weeks appears to be adequate for extended exercises.

4. Correct and return the assignments as soon as possible. Feedback on what you expect and what they have done is very important.
    - I make it a habit to collect an assignment during Friday's class and return it the following Monday.

5. Get your students to read their textbook. The style of writing in it will give them some idea on how to write mathematics.